Geophysical Research Abstracts
Vol. 13, EGU2011-8328-1, 2011
EGU General Assembly 2011

Quantification of the impact of climate change on thermal power plants in Germany - A System Dynamics modelling approach

Bastian Hoffmann, Sebastian Häfele, and Ute Karl
European Institute for Energy Research, Emmy-Noether-Str. 11, 76131 Karlsruhe, Germany (bastian.hoffmann@eifer.org)

In Germany, around 72 % of electricity production still come from energy sources like hard coal, lignite and nuclear (BMWi 2010), which are mostly used in thermal power plants with capacities larger than 300 MW (Platts 2007). Most of those power plants use river water for cooling purposes. The withdrawal and subsequent discharge of the cooling water back into the river is restricted by legal thresholds, which can force power plant operators to reduce performance. This was observed in several German nuclear power plants in the summers of 2003 and 2006 (DAF 2004, 2007). As a consequence, legal thresholds in combination with periods of high river water temperatures affect the production of electricity. Water temperatures are, as air temperatures, expected to rise due to changes in climate. In this study we analyse the impacts by modelling two main cooling systems: once-through cooling (OTC) and closed circuit cooling (CCC) of thermal power plants based on System Dynamics (SD). To simulate climate change in the model, we use data derived from the model REMO (Jacob et al. 2007) for the scenarios A1B, A2, and B1 (2011-2100) as well as projected water temperature (Strauch 2011, in press) and wet bulb temperature data (Paeth & Aich 2010). Both the OTC and the CCC model were validated with observed data of DAF (2007) and ex post data of power plant operators. Various power plant sites were analysed, since the model can be adapted by varying a limited number of site specific parameters like capacity, efficiency, or quantity of cooling water.

Results for all cooling systems and climate scenarios show significant negative trends in performance and significant differences to the control run (1961-1990). OTC systems show the largest performance losses due to threshold violation, whilst CCC systems often show negligibly low to no restrictions of electricity production. E.g., for the nuclear power plant Krümmel (OTC) the average losses in summer months can be as high as 3 % of total capacity. For unit 1 of the power plant Mainz-Wiesbaden (OTC) the reductions can reach up to 30 % in summer months. For the two power plant units Gundremmingen B and Isar 2 (CCC), the restrictions in the summer months amount to ca. 1.5 % and are mainly due to efficiency losses caused by higher cooling water temperatures.

The results of the different scenarios can be used as an indicator for possible future restrictions in electricity production of individual power plants due to climate change. In consequence, the modelling approach provides a basis to quantify impacts of climate change on the electricity production, and is therefore able to support the evaluation of possible adaptation measures.